Joint Authors

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UH - ?
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DRAFT TPRN - MULTIPATH MEASUREMENTS

Introduction and Background

At the last PRN working group meeting (March 1 and 2) a preliminary discussion of modulation techniques took place. One of the outcomes of this discussion was a decision to consider a spread-spectrum modulation format as a high-priority candidate for the PRN. Such a format, combined with time-of-arrival capture at the receiver might provide several advantages--including improved channel throughput, improved multi-path immunity, and the possibility of splitting the channel into orthogonal channels which could be used simultaneously. Compared to frequency splitting this form of channel splitting retains the advantage of demand-allocation which is fundamental to the PRN concept. Compared to pure time-sharing (as in Aloha) this form of channel splitting may provide a means to separate long-packet users from short-packet users, to provide a reservation channel, or to separate incoming from outgoing traffic. As an additional bonus, a spread spectrum format will provide a degree of privacy due to the lower power-density levels needed and a degree of anti-jam protection due to the wideband format.

We also discussed at the meeting the effect of multipath on spread spectrum and other modulation formats. Although there was no general agreement on the impact of multipath we did agree that it would be an important factor which must be taken into account in system and component design.

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In a separate discussion, SRI, University of Hawaii, and Collins representatives pooled their knowledge of the urban and suburban propagation channel and agreed that more detailed information was needed. The channel has been carefully characterized by several researchers (–) with respect to mean propagation loss versus range; and many measurements have been made of the statistical distribution of received signal amplitude level. However, these characterizations were made to be useful in designing mobile-radio systems which are generally narrow-band voice links. As such the great mass of available data does not adequately describe the channel for the wideband digital data transmission necessary for the PRN. Only Turin ( ), ( ) and Cox ( ) and Schmid have made measurements which are directly useful. These measurements were made by transmitting a high-power, short duration pulse, and taking pictures of the waveform received at various ranges and with the receiver in different multi-path environments.

These measurements have provided important insight into the multi-path problem, and are adequate for many purposes; however, in all cases they were made with signal bandwidths on the order of 2-3 MHz, so that the several paths were not resolved in time. Furthermore, the data were not taken and analyzed in a manner which will allow accurate prediction of the performance of time-of-arrival capture receiving techniques.

Because we feel that additional data are needed to adequately compare PRN design alternatives and to maximally use the results of ongoing experiments with the U. H. Aloha system, SRI, U.H., and Collins propose to undertake a two-phase experiment to characterize the urban/suburban multi-path channel.

We will jointly participate in all phases of the experiment, however to facilitate management and coordination we will each accept responsibility for the different aspects of the experiment during the first phase as follows:

SRI will be responsible for experimental design and overall coordination of the experiment.

Collins will provide the bulk of the hardware needed to generate and receive the signals.

University of Hawaii will collect the data.

Suggestion only - maybe we don't wish or need to articulate these responsibil Or maybe audi split is better Comments are solicited

Objective

The objectives of the proposed experiments are threefold.

a. To obtain fundamental measurements which characterize the PRN multi-path channels in a manner directly useful to design and performance analysis of the PRN system.

b. To provide a test bed for experimental evaluation of time-of-arrival capture techniques used with spread-spectrum signals.

c. To characterize the channels used on the Aloha system in Hawaii in such a way that the experimental results obtained by the U.H. will be directly useful in design of the PRN and may be extrapolated to channels in other locations.

Secondary to these objectives, but important to experimental design, the data should be taken in such a way that it will be useful to the

present and future radio designers who must contend with the urban and suburban channel and so that it can be compared, where applicable, to prior measurements.

Preliminary Description of the Experiment

We propose to make the experiment in two phases. The first phase, which will proceed as rapidly as possible will be performed in Hawaii using off-the-shelf hardware in order to obtain quick-look results. These results will be used to modify the experiment and hardware during the second phase as necessary to achieve the objectives.

During the second phase the experiment will be repeated using whatever modifications are necessary. Data will be taken in Hawaii as well as in areas designated by the PRN working group as candidates for the prototype net.

Our preliminary experimental design calls for radiation of a spread-spectrum waveform at three carrier frequencies. One in the vicinity of 400 MHz, one near 1 GHz, and one near 3 GHz. The bandwidth of the waveform will be as high as possible to provide as much multi-path resolution as we can get. Our preliminary goal is a bandwidth exceeding 5 MHz. Ultimately (Phase II) we should use 20 MHz to 50 MHz in order to obtain adequate time resolution. The waveform radiated will be either a chirp frequency signal or a PRN bi-phase modulated signal. In either case we will use as large a time-bandwidth product as possible in order to reduce the required radiated power level.

The signal will be received with a matched-filter receiver, probably implemented as an acoustic surface wave device. The output of the matched filter will be sampled, A/D converted, and stored on digital tape for analysis. Pictures of typical receiver outputs will be taken.

Anything else to be said?